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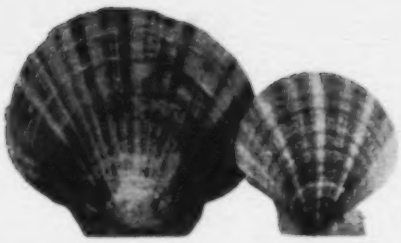
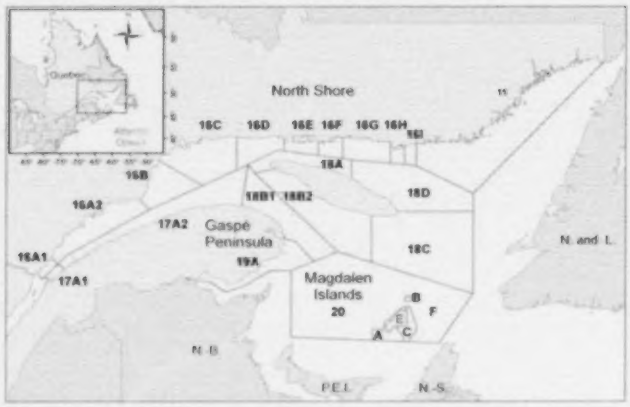
Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2016/027

2015 STOCK ASSESSMENT OF SCALLOP IN QUEBEC INSHORE WATERS





Source: DFO 2011.

Figure 1. Scallop fishing areas in Quebec.

Background

Two scallop species are fished commercially in the Gulf of St. Lawrence, namely the Sea Scallop (Placopecten magellanicus) and the Iceland Scallop (Chlamys islandica). A Digby dredge is used to harvest scallops near shore, and catches are landed mostly as meat (muscle). Given the difficulty to visually distinguish the meat of the two species, commercial fishing statistics are presented regardless of the species. However, scallops caught in one area are usually of the same species.

Quebec waters are divided into 24 fishing areas (Figure 1) where access is limited to a small number of fishermen. Fishing effort is also regulated by a fishing season, and catches are restricted by quotas or a limited number of fishing days.

The resource is assessed every three years to determine whether recent changes in the status of the resource may justify adjusting the conservation approach and management plan. The main indicators used in this assessment are derived from landing, logbook and commercial catch sampling data.

This Science Advisory Report is from the February 24, 2016 meeting on the Stock Assessment of Scallop in Quebec Inshore Waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Canada

SUMMARY

- From 2013 to 2015, Quebec's average annual scallop landings totalled 63 t of meat, a 10 percent decrease from 2010–2012. Also, fishing effort dropped by 11 percent from 2010–2012. Seventy-three percent of the landings were from the Magdalen Islands, 23 percent from the North Shore and 4 percent from the Gaspe Peninsula.

North Shore

- Landings decreased by 25 percent in comparison to 2010-2012, whereas fishing effort increased by 14 percent.
- From 2013 to 2015, there was no fishing effort in areas 16A1, 16A2, 16B, 16G, 16H, 16I and 18D and very little in areas 15, 16C, 16D and 18A. The status of the resource is therefore unknown in these areas.
- Since 2008, in Area 16E the fishery has been concentrated in bed D located south of Grande Île, where recruitment had been very good in previous years. Commercial catches per unit effort (CPUEs) in the last three years were below the 1992-2012 average and in the last two years were among the lowest in the historical series. The average weight of meat landed from 2013 to 2015 remains below the historical average. The last research survey (2014) indicated that the density of non-commercial-size scallops was above average and the highest value in the series, whereas the density of commercial sizes remained very low. Most indicators suggest that the exploitation rate is too high. It is therefore recommended that the average level of effort in the last three years not be exceeded and that fishing effort in bed D be reduced.
- In Area 16F, logbook CPUEs were very low from 2013 to 2015 and remain below the average of the historical series. The average weight of meat landed from 2013 to 2015 is near the historical average. The last research survey (2014) indicated that the density of commercial-size scallops was below the series average, whereas the density of non-commercial sizes was average and without trend since 2004. It is therefore recommended that the average level of effort in the last three years not be exceeded.

Gaspe Peninsula

- Scallop landings and fishing effort decreased by 52 percent and 57 percent respectively in 2013-2015 compared to 2010-2012.
- From 2013 to 2015, there was little if any fishing effort in areas 17A1, 17A2, 18B1, 18B2 and 18C. The status of the resource is therefore unknown in these areas.
- In Area 19A, landing and fishing effort values in 2015 were the lowest in the historical series. CPUEs have been low and stable since 2012. In the last two years, the fishery primarily exploited two beds. It is therefore recommended that fishing effort not be increased in these two beds.

Magdalen Islands

- In Area 20A, Sea Scallop landings increased significantly in 2007 and have since been stable. Fishing effort is evenly distributed within the beds.
- CPUEs increased significantly in 2007 and have been fairly stable since then, albeit below levels in the 1980s.

- The 2015 research survey indicated a post-2009 rise in the abundance trend of commercial-size (100 mm and over), pre-recruit (85 to 100 mm) and 70 to 85 mm scallop. Abundance nearly reached maximum values, which were well above the reference series average (1987-2008).
- Decision rules to calculate fishing effort have been in place since 2010. This effort is calculated using logbook CPUEs and research survey abundance indices. Fishing effort is to be reviewed annually after the indicators have been updated. The maximum fishing effort calculated for Area 20A in 2016 is 329 days at sea.
- In 2015, a research survey was conducted on the portion of the Dix-Milles bed located in Area 23. The areas inhabited by Sea Scallop and Iceland Scallop in Area 23 are 38.4 and 27.4 km^2 respectively. According to the analysis of observed scallop range and densities, the part of the bed located in Area 23 is an extension of the bed located in Area 20A. The Iceland Scallop bed is evenly split between both areas.

INTRODUCTION

Biological context

Two scallop species are indigenous to Quebec, namely the Sea Scallop (*Placopecten magellanicus*) and the Iceland Scallop (*Chlamys islandica*). These two species mainly inhabit gravel, shell or rock substrates, generally at depths of between 20 and 60 metres. Scallops are sedentary and live in aggregations called beds. This feature must be taken into consideration in developing conservation strategies and fishery management plans. The main Iceland Scallop beds exploited are located along the North Shore, Anticosti Island and along the north shore of the Gaspe Peninsula (Figure 2), whereas the exploited Sea Scallop beds are located mostly in the southern Gulf, including the Magdalen Islands, Chaleur Bay, and occasionally, along the Lower North Shore.

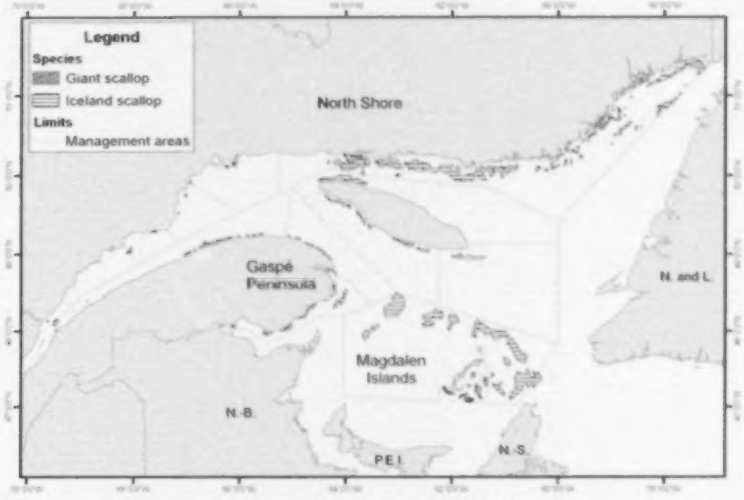


Figure 2. Known range of the Sea Scallop and Iceland Scallop in Quebec coastal waters.

The Sea Scallop grows more quickly than the Iceland Scallop. Scallop growth rate varies between areas and is influenced by habitat quality and environmental conditions. In the Gulf of

St. Lawrence, Iceland Scallops reach commercial size at about eight years (70 mm) and Sea Scallops at about six (100 mm).

In scallops, the sexes are separate and eggs are fertilized externally. A scallop's egg production is proportional to its size cubed, and successful fertilization depends on the proximity of other scallops. The spawning period is short and does not occur at the same time throughout the Gulf. Along the North Shore and around Anticosti Island, spawning occurs between mid-July and late August, depending on the area. Sea Scallops spawn in August in Chaleur Bay and begin in late August in the Magdalen Islands.

Larval development takes about five weeks from fertilization to settlement on the seabed. During this time, the larvae are dispersed throughout the water column. Juvenile scallops generally attach themselves to the seabed near the adults. Scallop beds are usually found in areas where currents enhance larvae retention, but a good substrate is needed to ensure the successful attachment of juveniles. During the settlement period, juveniles are very sensitive to disturbance of the sediment by fishing gear. To ensure the survival of juveniles settled on the bottom, it is recommended that scallop beds not be dredged from August to November.

The meat yield by weight of a scallop of a given size varies over the reproductive cycle. Muscle weight peaks in spring just before gonad development, drops to its lowest point during the spawning period and starts rising again in the fall.

Description of the fishery

The commercial scallop fishery in Quebec began in the late 1960s. Scallops are primarily harvested near shore using a Digby dredge. The commercial fishery targets both scallop species. Catches are generally landed as meat (muscle) and the statistics provided in this report are expressed as meat weight. The difficulty in visually distinguishing between the meat of the two species complicates the analysis of fishing statistics. However, the two species are not distributed uniformly throughout the Gulf of St. Lawrence, and catches in any one area usually consist of just one species.

Quebec waters are divided into 24 fishing areas, which are grouped into three sectors, the North Shore (areas 15, 16A1, 16A2, 16B, 16C, 16D, 16E, 16F, 16G, 16H, 16I, 18A, 18D), the Gaspe Peninsula (areas 17A1, 17A2, 18B1, 18B2, 18C, 19A) and the Magdalen Islands (areas 20A, 20B, 20C, 20E and 20F) [Figure 1]. Few fishermen operate in most of these areas and there has been little if any fishing effort there. In 2015, 77 regular licences and two exploratory licences were issued. Management plans were developed for each area, based on the following factors: vessel length, dredge size (<7.31 m), fishing season and hours, individual and overall quotas or number of fishing days permitted (Table 1).

A major change in fishery management methods in areas 16E, 16F and 18A occurred in 2006. Harvesting is now managed by regulating fishing effort, i.e. by limiting the number of fishing days for the season and fishing hours per day. Management based on the number of fishing days has also been applied to Area 20A of the Magdalen Islands since 2007, and decision rules have been used to calculate fishing effort since 2010.

Table 1. 2015 scallop fishery management measures.

Area	Number of Licences	Quota (t meat or days at sea)	Season (day/month)	Daily schedule	Dockside Monitoring	Hail out	Hail in	At-sea Observers (% of trips)	VMS[1]	Size Limit and Meat Count[2]
15	33 + 2[3]		19/05 - 30/11							
16A1	1	10.9 t	15/04 - 06/12			100%	100%	5%	100 %	
16A2	1	3.8 t	15/04 - 06/12				100%		100 %	
16B	1	6.8 t	15/04 - 22/11				100%			
16C	2	12.8 t	13/05 - 01/11		100%	100%	100%	5%		
16D[4]		6.1 t	15/04 - 08/11				100%			
16E	9	140 days[5] (277 days)	23/04 - 31/12	5 a.m. – 8 p.m.	Sporadic	100%	100%		100 %	
16F	9	50 days[6] (164 days)	23/04 - 31/12	5 a.m. – 8 p.m.	Sporadic	100%	100%		100 %	
16G[7]	3	13.7 t	22/04 - 15/11				100%			
16H[8]	8	8.3 t	15/04 - 08/11		100%		100%			
16I[9]			19/05 - 30/11							
17A1	1	10.9 t	01/04 - 30/11			bef. 7 p.m. prev.	100%	5%	100 %	100 mm; 30
17A2	1	4.0 t	01/04 - 30/11				100%		100 %	100 mm; 30
18A	9	258 days	23/04 - 31/12	6 a.m. – 9 p.m.	Sporadic	100%	100%			
18B1	3		01/05 - 30/09				100%		100 %	100 mm; 30
18B2	3	16.0 t	01/04 - 30/11				100%		100 %	100 mm; 30
18C	3	11.0 t	01/04 - 30/11		100%		100%		100 %	
18D[10]	1	10.0 t	29/04 - 08/11				100%			
19A	1		01/05 - 30/11	Day[11], time			100%		100 %	100 mm; 30
20A	23	322 days	30/03 - 08/08				100%		100 %	100 mm; 30
20B	23		30/03 - 08/08				100%		100 %	100 mm; 30
20C	23		30/03 - 08/08				100%		100 %	100 mm; 30
20E	Refuge Area									
20F	23		30/03 - 08/08				100%		100 %	100 mm; 30

[1] = Vessel monitoring system (VMS)
[2] = Meat count: maximum number of muscles in 500 g
[3] = Exploratory licence for Iceland Scallop
[4] = Open to all scallop licence holders residing between Sept-Îles and Pointe Parent
[5] = Provisional fishing effort, a total of 140 fishing days are allowed, including a maximum 100 days in bed D
[6] = Provisional fishing effort, 50 fishing days are allowed
[7] = Open to fishermen in group A
[8] = Open to group A scallop fishermen and 6 scallop fishermen from the Lower North Shore without a crab licence.
[9] = Open to all Area-15 scallop licence holders
[10] = Open to all scallop licence holders residing from Tadoussac to Pointe-Parent
[11] = Depending on the day of the week, Monday to Friday from 5 a.m. to 6 p.m. (Cap Gaspé to Miguasha) and Saturday from 5 a.m. to noon (Cap Gaspé to Port-Daniel)

From 2013 to 2015, average annual landings totalled 63 t of meat, a 10 percent decrease from 2010-2012 (Figure 3). The landings, in decreasing order of weight, were from the Magdalen Islands (73 percent), the North Shore (23 percent) and the Gaspe Peninsula (4 percent). During the same period, fishing effort in Quebec decreased by 11 percent from 2010-2012 (Figure 4).

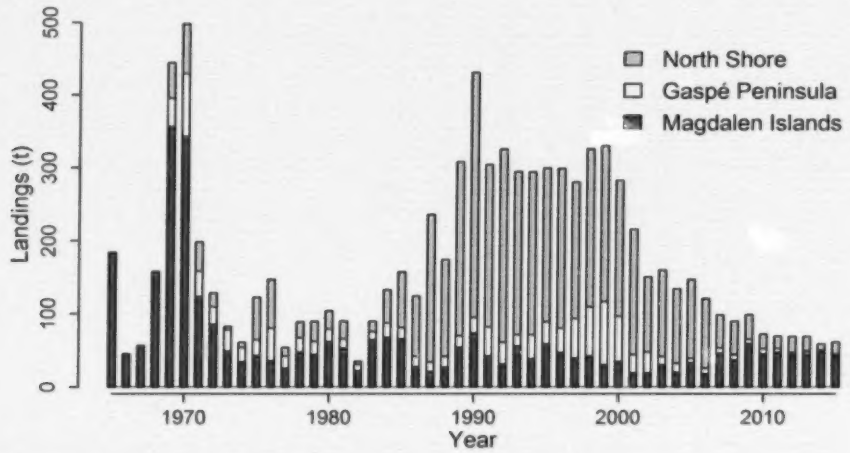


Figure 3. Scallop landings in Quebec.

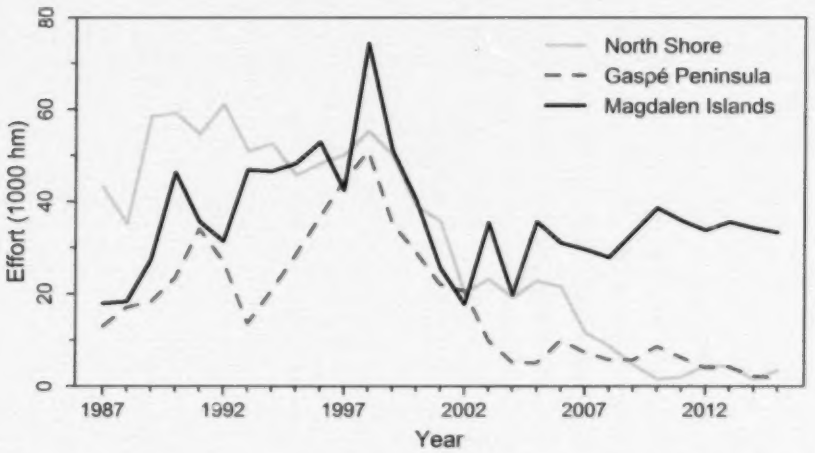


Figure 4. Fishing effort in Quebec (standardized fishing hours per metre of dredge width).

RESSOURCE ASSESSMENT

The assessment of the status of scallop populations is based mainly on an analysis of commercial indices derived from logbooks and sampling at sea or at dockside (Tables 2 and 3). It is also based on indices derived from research surveys conducted out every two years on scallop beds in the Mingan area (areas 16E and 16F) and the Magdalen Islands (Area 20A).

Table 2. Catch per unit effort (kg of meat per hour of fishing and metre of dredge width) estimated from logbooks.

Year	Fishing Area								
	15	16D	16E	16F	17A2	18A	18B1	19A	20A
2003	1.64	0.76	2.38	2.06	1.27	1.50	1.44	0.68	0.87
2004	2.09	3.70	1.89	2.35		1.44	2.31	0.72	0.87
2005	2.08		1.74	2.10		1.55	5.81	0.83	0.84
2006	2.34		1.57	1.65	0.60	1.27	2.03	0.85	0.60
2007	1.74		1.38	1.55	0.48	1.13	2.60	0.92	1.64
2008			1.80	1.61		1.11	2.38	1.12	1.37
2009	1.97		1.92	1.37	0.66	0.48	2.71	0.95	1.83
2010	1.73		1.83		1.24		2.91	0.81	1.24
2011	1.41		2.14	1.30			4.20	0.73	1.35
2012	1.25		1.67	1.38	0.64		0.99	0.64	1.32
2013			1.72	1.40		0.84		0.80	1.30
2014			1.34	1.59				0.65	1.44
2015	1.53	5.14	1.42	1.36	3.12	0.74	7.58	0.69	1.31
1992-2012 Average	1.72	4.84	1.80	1.81	1.35	1.26	2.07	0.93	1.04

*: kg of meat per fishing tow and metre of dredge width

Table 3. Average weight of landed meat (g).

Year	Fishing Area								
	15	16D	16E	16F	17A2	18A	18B1	19A	20A
2003	13.0		13.5	14.2	17.1	9.9		21.0	19.7
2004			13.0	12.0		8.0	29.3	19.9	21.7
2005	16.8		10.4	10.9		10.0	32.4	16.1	21.0
2006	12.9		11.5	11.2	13.0	7.7	30.8	16.4	18.5
2007			12.2	11.6	11.9		35.7	21.1	19.2
2008			11.3	11.3			36.1	19.5	27.8
2009			10.8				31.0	18.1	16.1
2010			10.7				42.4	20.9	23.6
2011			11.2	11.2			34.8	21.7	24.0
2012			11.9	12.1				20.9	27.3
2013			12.2	11.1				18.9	26.7
2014			11.5					18.6	24.8
2015			12.9	11.8		8.1	34.5	20.9	24.8
1992-2012 Average	14.4	11.8	13.1	11.4	15.0	9.9	34.1	18.6	19.9

North Shore

Iceland Scallops are harvested along the entire North Shore of the Gulf of St. Lawrence, while Sea Scallops are taken only along the Lower North Shore. The North Shore is divided into 13 separate fishing areas located between the mouth of the Saguenay River and Blanc Sablon and along the north shore of Anticosti Island. Average North Shore landings were approximately 15 t of meat between 2013 and 2015. Compared to 2010-2012, average annual landings from 2013 to 2015 decreased by 25 percent, and fishing effort increased by 14 percent. The landings came from the Mingan Archipelago area (areas 16E and 16F) and the North Shore of Anticosti Island (Area 18A).

Upper North Shore (Scallop Management Areas 16A1, 16A2, 16B and 16C)

No landings have been recorded since 2010 in Upper North Shore areas (Figure 5) except in Area 16C in 2015. Landings in this Area were from a two-day exploratory fishery conducted in the fall of 2015. These areas are harvested by five fishermen and fishing effort is regulated by the number of licences and quotas issued.

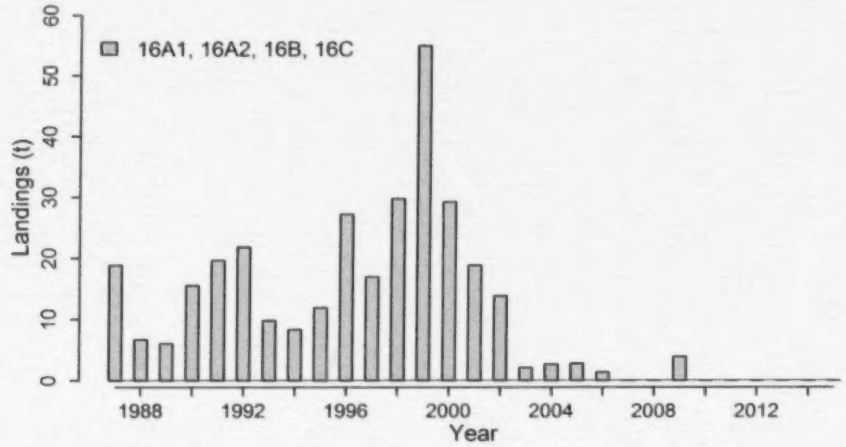


Figure 5. Scallop landings from areas 16A1, 16A2, 16B and 16C.

Middle North Shore (Scallop Management Areas 16D, 16E, 16F, 16G and 18A)

Nine fishing licences provide access to areas 16E, 16F and 18A; five licences are for Area 16G, and all Middle North Shore scallop fishermen have access to Area 16D. Each Area is regulated by a quota, and there are daily and seasonal restrictions on fishing effort. Middle North Shore landings for 2013, 2014 and 2015 were only 19.5, 8.5 and 16.2 t of meat respectively. The 2014 landings value was the lowest of the historical series. Landing levels remain very low compared to the numbers for initial exploitation in these areas (Figure 6).

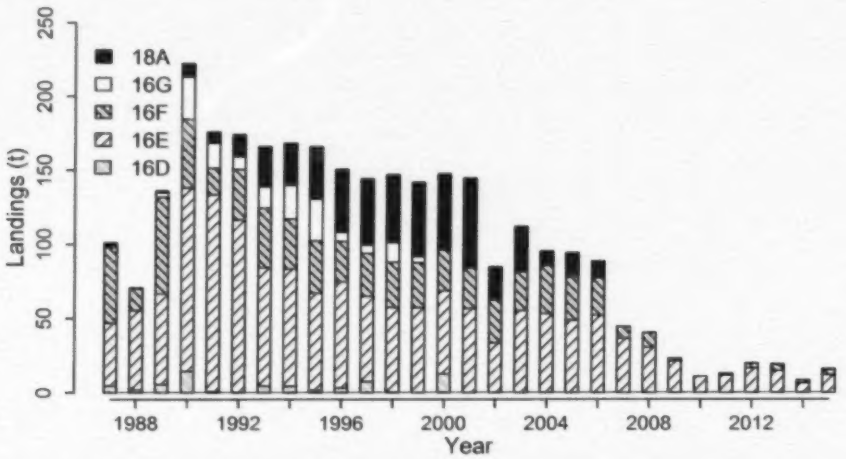


Figure 6. Scallop landings from areas 16D, 16E, 16F, 16G and 18A.

From the Manitou River to the Île aux Perroquets lighthouse (Area 16D), there has not been any fishing effort since 2005 except in 2015 when there was one day of fishing. Since 1996, landings and yields have been low because fishing effort has been sporadic in this area.

In Area 16E, landings were stable at 50–60 t from 1997 to 2006. They subsequently dropped until 2010, reaching 11 t, and then increased slightly to 17 t in 2012. A historic 7 t low was reached in 2014 and landings were only 12 t in 2015 (Figure 6). During the same period, fishing effort dropped steadily from over 200 days at sea to under 100 days out of an authorized total of 277. Since 2008, fishing effort has been primarily concentrated on a single bed: bed D south of Grande Île, where strong cohorts recruited to the fishery beginning in 2007. This strong recruitment had been previously identified since 2003 during research surveys. There were very few harvesting operations in the other beds in the last three seasons, except for bed Q in 2015. CPUEs in the last three years were below the 1992-2012 average, and in the last two years were among the lowest in the historical series (Table 2). The average weight of meat landed from 2013 to 2015 is higher than from 2010-2012, but still below the historical average (Table 3). The increase in average weight recorded in 2015 reflects the resumption of harvesting operations in bed Q.

The 2014 research survey indicated that the density of commercial-size scallops remained low and was the second lowest density value in the historical series (Figure 7). The density of non-commercial-size scallops was above average and represented the highest density in the series (Figure 7).

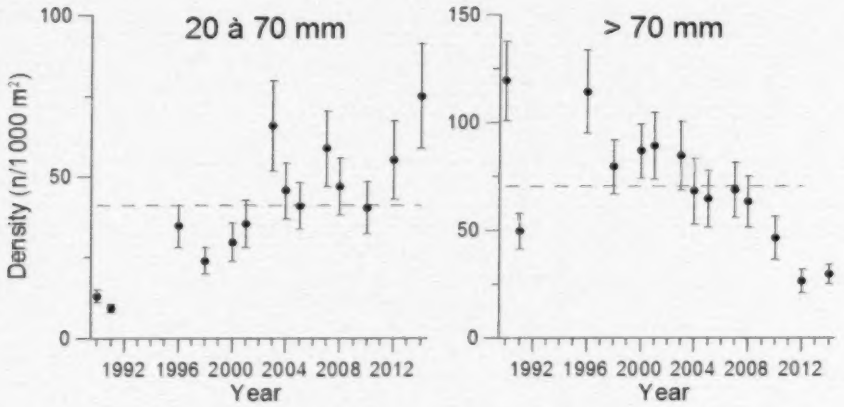


Figure 7. Density index of non-commercial (20 to 70 mm) and commercial (>70 mm) scallops based on research surveys in the Mingan area, Area 16E (± standard error). The dotted lines represent the averages for the 1990-2014 series.

Landings and fishing effort from 2013 to 2015 in Area 16F were greater than in 2010-2012. On average, landings were 3.1 t, and there were 22 days of fishing effort per season out of an authorized total of 164 days (Figure 6). Logbook CPUEs were very low and remained below the average of the historical series (Table 2). The average weight of meat landed from 2013 to 2015 is near the historical average (Table 3). The 2014 research survey indicated that the density of commercial-size scallops remained below average and was the second lowest density value of the series. No trend was observed in non-commercial-size scallops between 2004 and 2014 (Figure 8).

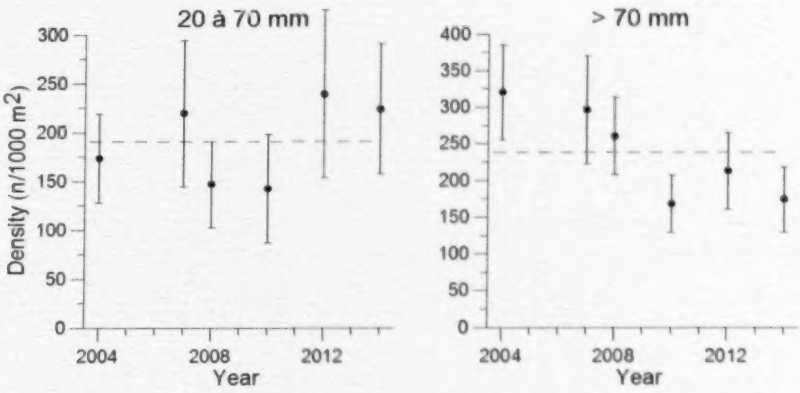


Figure 8. Density index of non-commercial (20 to 70 mm) and commercial (>70 mm) scallops based on research surveys in the Mingan area, Area 16F (± standard error). The dotted lines represent the averages for the 2004-2014 series.

In Area 16G, between Johan Beetz Bay and Natashquan, landings, fishing effort and catches per unit effort varied until 2005 (Figure 6), and there have been no landings since then.

There were few harvesting operations in Area 18A from 2013 to 2015 although the area was open for 258 days (Figure 6). Landings and fishing effort dropped significantly in 2002 and continued to decline steadily until 2009. CPUEs decreased during the same period. CPUEs were very low from 2013 to 2015 and remained below the historical series.

Lower North Shore (Scallop Management Areas 16H, 16I and 15)

In 2015, eight scallop fishing licences were issued for Area 16H, and 33 regular and two exploratory licences were issued for Iceland Scallop harvesting in areas 15 and 16I. Prior to 1992, most of the Lower North Shore landings were Sea Scallop, but from 1992 to 1998, Iceland Scallop landings from areas 16H and 16I increased. Since 1998, Lower North Shore landings of both scallop species have dropped, totalling only 0.03 t of meat in 2015 (Figure 9). There was no fishing effort in Area 15 in 2013 and 2014. There have been no fishing operations in areas 16H and 16I since 2004 and 2005 respectively.

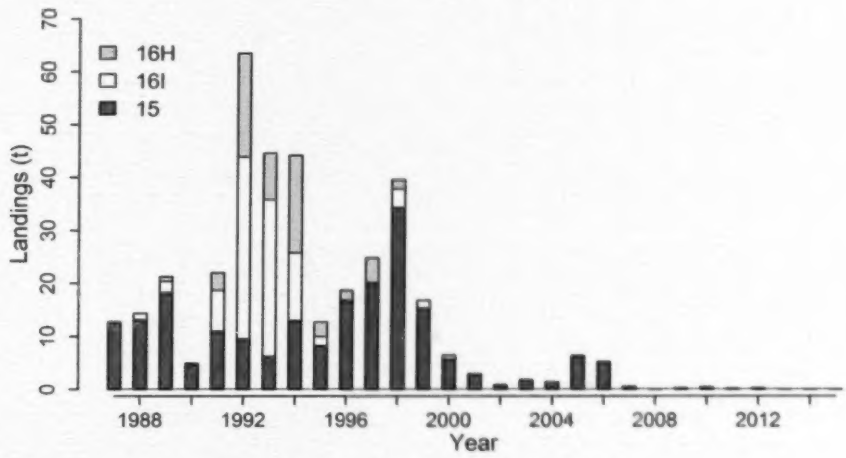


Figure 9. Scallop landings from Lower North Shore areas 16H, 16I and 15.

Gaspe Peninsula (Scallop Management Areas 17A1, 17A2, 18B1, 18B2, 18C and 19A)

The Gaspe Peninsula is divided into three fishing sectors: the St. Lawrence Estuary and the north shore of the Gaspe Peninsula (17A1, 17A2 and 18B1), Anticosti Island (18B2 and 18C) and Chaleur Bay (19A). The number of licenses is limited in each Area. In 2015, only one licence was issued for areas 17A1 and 17A2, three in areas 18B1, 18B2 and 18C and one in Area 19A. Each area had its own fishing season, and quotas were set in areas 17A1, 17A2, 18B2 and 18C.

Landings in the Gaspe Peninsula gradually started to increase in 1993, peaking at about 80 t of meat in 1999. Landings in the Gaspe Peninsula area dropped significantly in 2003 and have remained low since then (Figure 10). In 2015, landings in the Gaspe Peninsula totalled 2.0 t of meat. The lowest value of the historical series was reached in 2014 when 1.4 t of meat were landed. Average annual landings from 2013 to 2015 declined by 52 percent from 2010–2012, with fishing effort decreasing by 57 percent.

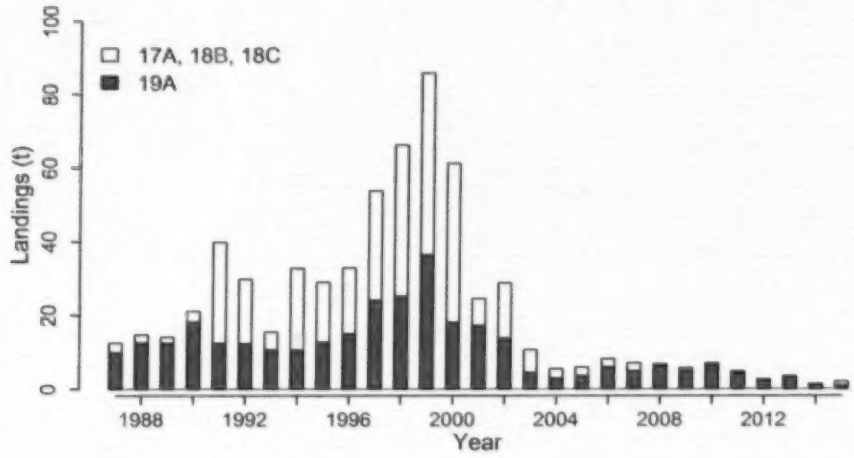


Figure 10. Gaspe Peninsula scallop landings.

There was little if any fishing effort in areas 17A1, 17A2, 18B1, 18B2 and 18C from 2013 to 2015.

In the wake of reduced fishing effort in Area 19A in 2003, landings fell significantly and subsequently stabilized somewhat at a 5 t per year average (Figure 10). Landing and fishing effort values in 2015 were the lowest in the historical series, 1.0 t and 42 fishing days. In the last two years, scallops were primarily harvested from two beds. Catch per unit effort had been decreasing since 2008, reaching one of the lowest values of the historical series in 2015 (Table 2). The average weight of Sea Scallop meat landed from 2013 to 2015 was slightly above the series average (Table 3).

Magdalen Islands (Scallop Management Area 20)

There are several scallop beds in the Magdalen Islands. They are located at Pointe-du-Ouest, Dix-Milles, Chaîne-de-la-Passe, Sud-Ouest, Île Brion and Banc de l'Est (Figure 11). Sub-area 20E is closed because it is a Sea Scallop refuge area.

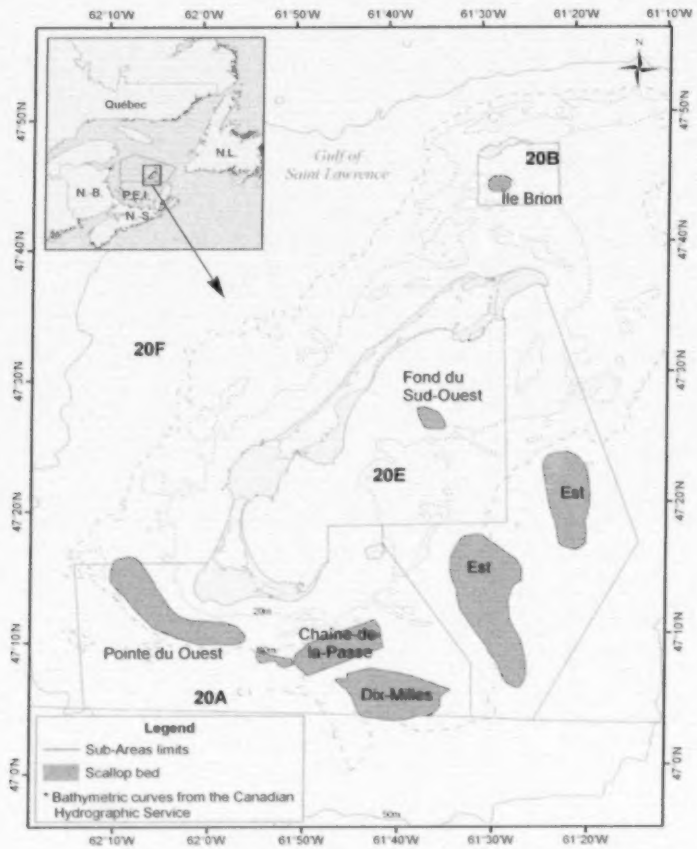


Figure 11. Sub-areas and main scallop fishing grounds in the Magdalen Islands.

Since 2007, fishing effort in Area 20A has been regulated by a total authorized number of days at sea, and areas 20B, 20C and 20F are regulated by a fishing season. Authorized effort in Area 20A was 322 days in 2013, 2014 and 2015. This maximum has been nearly reached every year. Annual fishing effort (hour • metre) has been stable since 2005 and is slightly above the 1992-2012 series average. Landings increased significantly from 18 to 46 t of meat in 2007 and have been stable since then (Figure 12). The fishing effort of the past three years has been well distributed over the three main beds in Area 20A (Pointe-du-Ouest, Dix-Milles and Chaîne-de-la-Passe), whereas annual fishing effort was low in areas 20B, 20C and 20F.

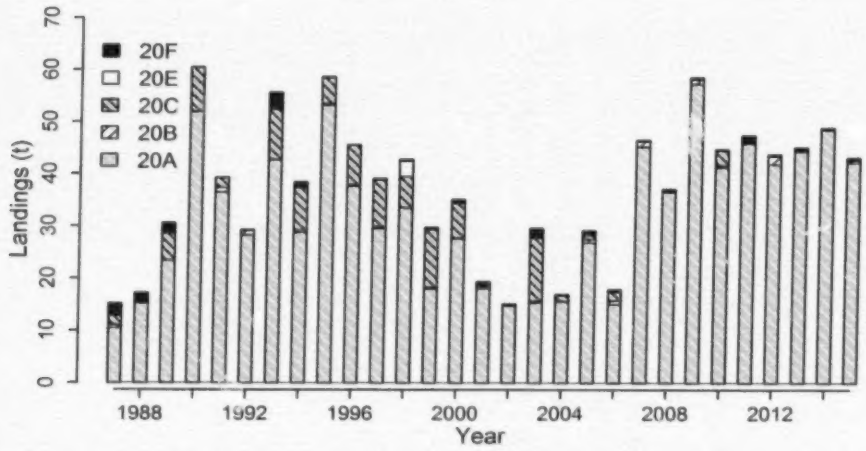


Figure 12. Scallop landings in the Magdalen Islands.

Catches per unit effort in 2013-2015 estimated from logbooks are similar to 2010-2012 CPUEs and still remain significantly higher than CPUEs in the early 2000s (Figure 13).

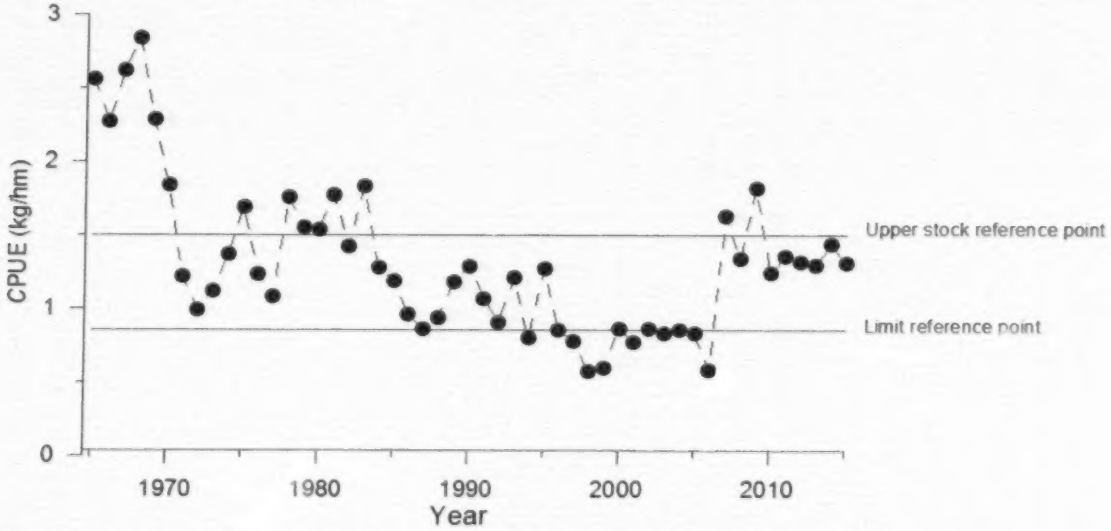


Figure 13. Catches per unit of effort (CPUEs) estimated from logbooks in Area 20A.

The 2015 research survey indicated a post-2009 rise in the abundance trend of commercial-size (100 mm and over), pre-recruit (85 to 100 mm) and 70 to 85 mm scallop. Abundance nearly reached maximum values, which were well above the medians of the reference series (Figure 14). The abundance of scallops smaller than 70 mm was above the median reference series.

A comparative fishery between two vessels was conducted in 2013 because Calanus II was being replaced by Canadian Coast Guard Ship (CCGS) Leim. The main objective of the study was to verify the need to apply the correction factor to historical data produced with Calanus II.

The study results showed that there was no significant difference in catches between the two vessels. Consequently, there was no need to apply a correction factor to the historical series.

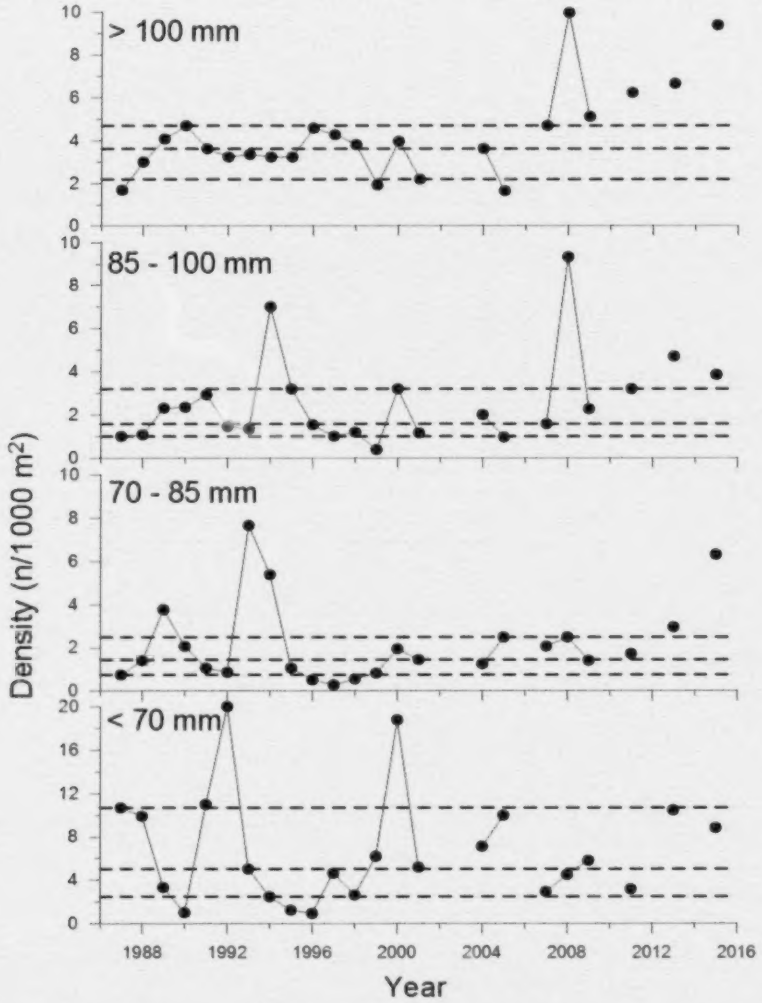


Figure 14. Density of Sea Scallops sampled at the Magdalen Islands during research surveys, by size category. The dotted lines indicate the 15th, 50th and 85th percentiles of the 1987-2008 series.

Decision rules have been used to calculate annual fishing effort in Area 20A since 2010. First, the CPUEs of the last two seasons are used to calculate fishing effort. If the final year's CPUE is higher than the previous year's CPUE, the average of the two values is used. Otherwise, only the CPUE of the final year is used. The selected CPUE is inserted into the decision rule chart in Figure 15 to determine whether it is low, average or high. The position of the CPUE on the chart determines the fishing effort for the following year. Second, the most recent research survey abundance results are used to adjust the fishing effort upwards or downwards within the grey area in Figure 15. The maximum fishing effort for the 2016 season would be 329 days at sea in Area 20A.

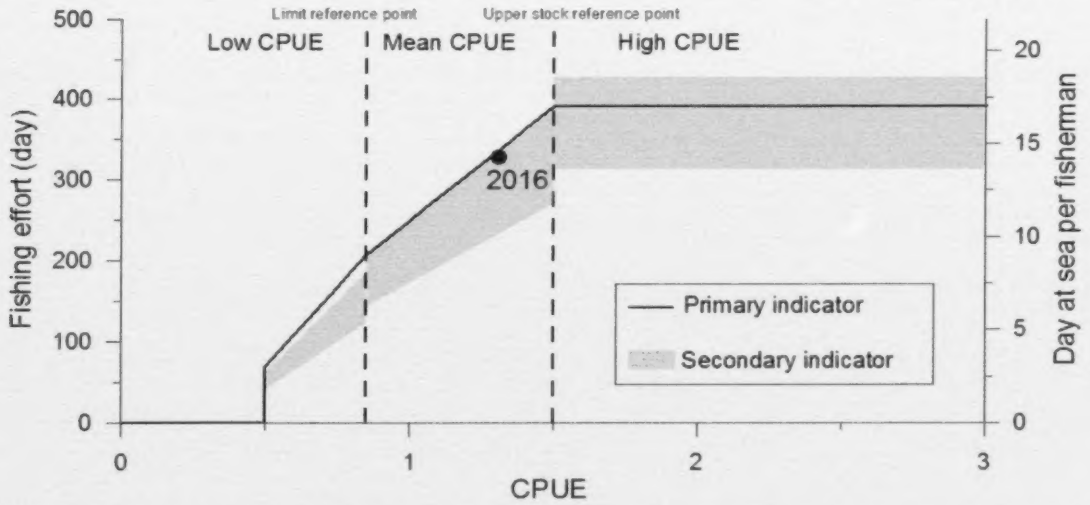


Figure 15. Calculation of fishing effort (days at sea) based on primary (CPUE) and secondary indicators (research survey indices) for Area 20A.

Portion of the Dix-Milles scallop bed located in Area 23 along the north coast of Prince Edward Island

Fisheries and Aquaculture Management (Magdalen Islands area) asked the Regional Science Branch of the Quebec Region for an assessment of the characteristics of the scallop population in the portion of the Dix-Milles bed that extends into Area 23. More specifically, Management wished to know what percentage of the Dix-Milles bed was located in Area 23, the scallop species inhabiting the bed and whether trends in the various components of the scallop population in the portion of the Dix-Milles bed located in Area 23 are the same as in Area 20.

The 2015 research survey results indicated that the Sea Scallop's range was mainly to the east of Area 23 whereas the Iceland Scallop's range was on the western side. Areas inhabited by Sea Scallop and Iceland Scallop in Area 23 are 38.4 and 27.4 km^2 respectively (Figure 16).

Sea Scallop densities for the four size classes in the Area 23 study area are 2.6 to 32 times lower than those observed in the portion of the Dix-Milles bed located in Area 20A (Table 4). Densities of pre-commercial and commercial size Iceland Scallops in the Area 23 study area are 3.6 to 3.3 times higher than those observed in the portion of the Dix-Milles bed located in Area 20A. Total areas inhabited by Sea Scallop and Iceland Scallop in the Dix-Milles bed are 108.7 and 58.7 km^2 respectively.

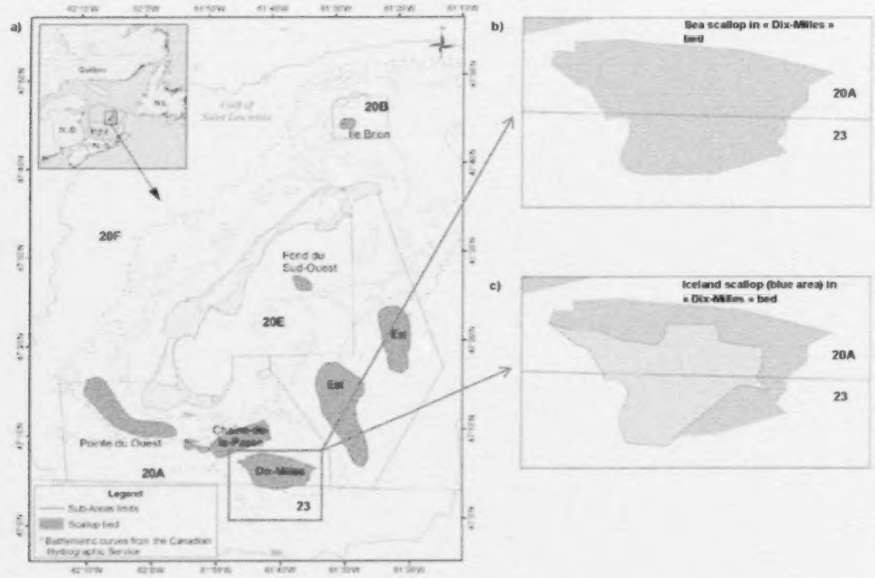


Figure 16. Boundaries of sub-areas and main Magdalen Islands scallop fishing grounds (a) area inhabited by the Sea Scallop (b) and the Iceland Scallop (c) in the Dix-Milles bed in areas 20A and 23.

Table 4. Comparison of 2015 research survey indices in Area 20A and the portion of the Dix-Milles bed located in Area 23.

Species	Indices	Size Class	20A Centre[1]	20A Dix-Milles	23	20A DM / 23[2]
Sea Scallop	Density (n/m^2)	0-70 mm	0.0057	0.0069	0.0006	11
		70-85 mm	0.0047	0.0061	0.0002	32
		85-100 mm	0.0021	0.0019	0.0006	3.1
		100 mm and +	0.0096	0.0117	0.0044	2.6
	CPUE (kg/hm)	100 mm and +	1.14	1.30	0.62	2.1
Iceland	Density (n/m^2)	0-70 mm	0.0042	0.0018	0.0062	0.28
		70 mm and +	0.0064	0.0043	0.0142	0.30
	CPUE (kg/hm)	70 mm and +	0.33	0.44	0.87	0.50

[1] = The centre area consists of the Chaîne-de-la-Passe and Dix-Milles beds in Area 20A
[2] = Ratio between the Dix-Milles (DM) bed in Area 20A and Area 23

The size structure of Sea Scallops in Area 23 is characterized by a few modal values in commercial sizes, suggesting settlement occurred in 2002, 2004, 2007 and 2008 (Figure 17). However, recruitment in Area 23 was very low compared to levels observed in the Dix-Milles bed in Area 20A. The main modal values observed in the size structure of Iceland Scallops were similar in both areas (Figure 17).

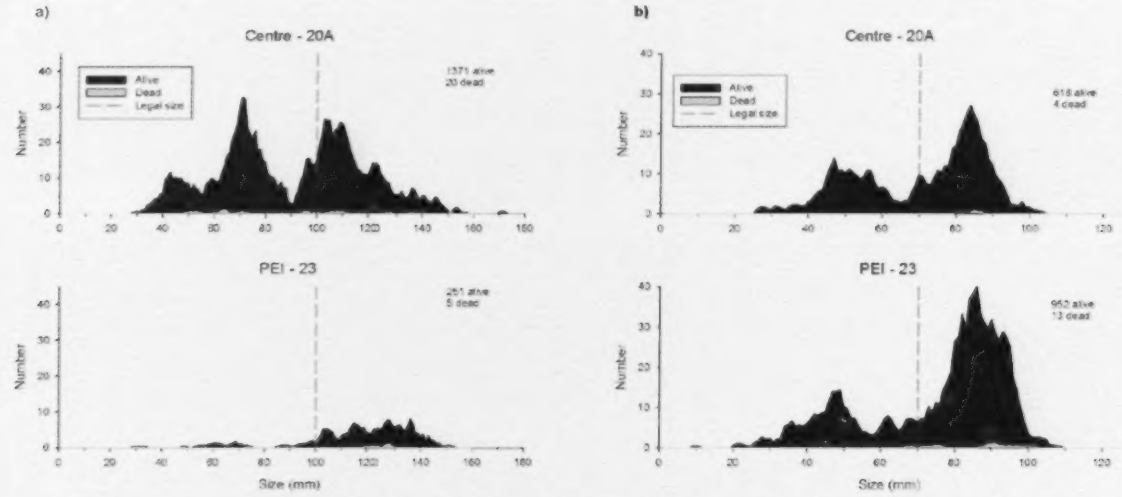


Figure 17. Size structure by number for the central area (20A) and Area 23, a) Sea Scallop and b) Iceland Scallop.

Sources of Uncertainty

This assessment is based on indices derived from logbook data and commercial catch sampling at sea and dockside. In addition, scientific surveys are conducted every two years in areas 16E, 16F and 20. Caution must be exercised when adjusting quotas or exploitation strategies if the sustainable exploitation rate is unknown.

There is very little if any fishing effort in several management areas. As a result, reliable resource status indicators are not available.

CONCLUSIONS AND ADVICE

North Shore

From the late 1980s to the mid-2000s, North Shore scallop landings have always accounted for more than 65 percent of Quebec catches. This percentage has fallen sharply in recent years due to poor socio-economic conditions for the scallop fishery in this area. As a result, fishing effort has declined significantly along the North Shore and has remained low since the early 2000s.

Scallop Management Areas 16A1, 16A2, 16B, 16C, 16D, 16G and 18D

From 2013 to 2015, there was no fishing effort in areas 16A1, 16A2, 16B, 16G and 18D and very little in areas 16C and 16D. The status of the resource is therefore unknown in these areas.

Scallop Management Areas 16E, 16F and 18A

The fishing effort management system, developed in 2006 for areas 16E, 16F and 18A, involved regulating the number of fishing days to keep the exploitation rate constant in situations where the fishing effort limit was reached. Constant effort meant a constant exploitation rate, and annual landings fluctuated depending on the status of the stock. Since its introduction, maximum effort has never been reached in the three areas. In addition, the provisional maximum of 140 and 50 days of fishing effort respectively authorized in areas16E and 16F from

2013 to 2015 was not reached. Some fishermen have stopped harvesting in certain areas or are not active. Fishing effort in Area 16E was similar to the effort deployed in 2010-2012 and was 46 percent of the authorized maximum provisional effort. Fishing effort in Area 16F doubled since 2010-2012 and was 43 percent of the authorized maximum provisional effort.

Since 2008, the fishery has been concentrated in Area 16E in bed D located south of Grande Île, where recruitment had been very good in previous years. Most indicators suggest that the exploitation rate is too high. It is therefore recommended that the average level of effort in the last three years not be exceeded and that fishing effort in bed D be reduced.

In Area 16F, most commercial size indicators are below average reference levels. It is therefore recommended that the average level for the last three years not be exceeded.

There were few harvesting operations in Area 18A during this assessment period. As a result, the status of the resource in the area is unknown.

Scallop Management Areas 16H, 16I and 15

For several years, Lower North Shore landings have remained low (Area 15) or non-existent (areas 16H and 16I). Information on these areas is incomplete and insufficient, making it difficult to assess the status of the resource.

Gaspe Peninsula

From 2013 to 2015, there was no fishing effort in areas 17A1, 18B2 and 18C and very little in Area 17A2. In 2015, there was some fishing effort in Area 18B1. However, the status of the resource is unknown in any of these areas.

In Area 19A, landing and fishing effort values in 2015 were the lowest in the historical series. CPUEs have been low and stable since 2012. Since 2014, following the buyout of two licences, there is only one dredge fisherman operating in Area 19A. In the last two years, scallops were primarily harvested from two beds. It is therefore recommended that fishing effort not be increased in these two beds.

Magdalen Islands

The Magdalen Islands scallop population declined for about 20 years to a very low abundance level in 2006. In 2007, potential fishing effort in Area 20A was reduced and regulated by a maximum number of fishing days at sea. Since then, landings have increased significantly and are stable, and CPUEs have remained above average. This improvement is attributable to the strong cohorts recruited to the fishery during this period as a result of more stringent fishing effort controls.

Short- and medium-term recruitment levels are expected to be higher than in the previous assessment period (2010-2012). It is therefore likely that CPUE values will remain similar to those in recent years. However, the status of this population is still precarious given its high dependence on recruitment. Thus, maintaining and developing measures to facilitate the escape of pre-commercial sizes will help sustain this resource.

Decision rules used to calculate fishing effort have been in place since 2010. Fishing effort is calculated using CPUEs from logbooks and abundance indices from the research survey. Fishing effort is to be reviewed annually after the indicators have been updated. The maximum fishing effort recommended for Area 20A in 2016 is 329 days at sea.

Portion of the Dix-Milles scallop bed located in Area 23 along the north coast of Prince Edward Island

According to a 2015 research survey conducted on the portion of the Dix-Milles bed located in Area 23, the areas inhabited by Sea Scallop and Iceland Scallop are 38.4 and 27.4 km^2 respectively. According to the analysis of observed scallop range and densities, the part of the bed located in Area 23 appears to be an extension of the bed located in Area 20A. However, Sea Scallop recruitment in this part of the bed is very low compared to recruitment observed in Area 20A, and commercial biomass may depend on settlement episodes that occurred between 2002 and 2008. The Iceland Scallop bed is evenly split between both areas.

OTHER CONSIDERATIONS

Conservation measures

The recommended scallop conservation measures are designed to ensure that each bed retains the ability to regenerate itself in order to ensure its sustainability. Any approach designed to boost reproductive potential, whether it involves leaving more adults on the seabed or creating refuge areas, will help conserve the resource. Also, because scallop egg production increases exponentially with shell height, allowing the population to age will result in a net gain in productivity. This strategy will increase the yield per recruit.

Scallops spawn in late summer, and juveniles settle on the seabed in the fall. Dredging the beds with fishing gear at this time of year reduces reproductive potential and stirs up the sediment, which can interfere with successful settlement of juveniles. Halting harvesting operations during the spawning and settlement periods (August to November) would limit the adverse effects of dredging on the substrate and favour the survival of juvenile scallops. A strategy for protecting the seabed where juveniles are very abundant should therefore be promoted. Subsequently, these areas could be closed to fishing until the cohorts have reached commercial size in order to maximize the yield per recruit and minimize incidental scallop mortality.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 24, 2016 meeting on the Stock Assessment of Scallop in Quebec Inshore Waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

DFO. 2013. Stock assessment on scallop of the inshore waters of Quebec in 2012. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/027.

Bourdages, H. and Goudreau, P. 2010. Stock assessment on scallops of the inshore waters of Quebec in 2009: commercial fishery data. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/068. viii + 69 p.

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